U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Office of Nuclear Energy
Advanced Modeling and Simulation Portfolio

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AMSO
ADVANCED MODELING & SIMULATION OFFICE

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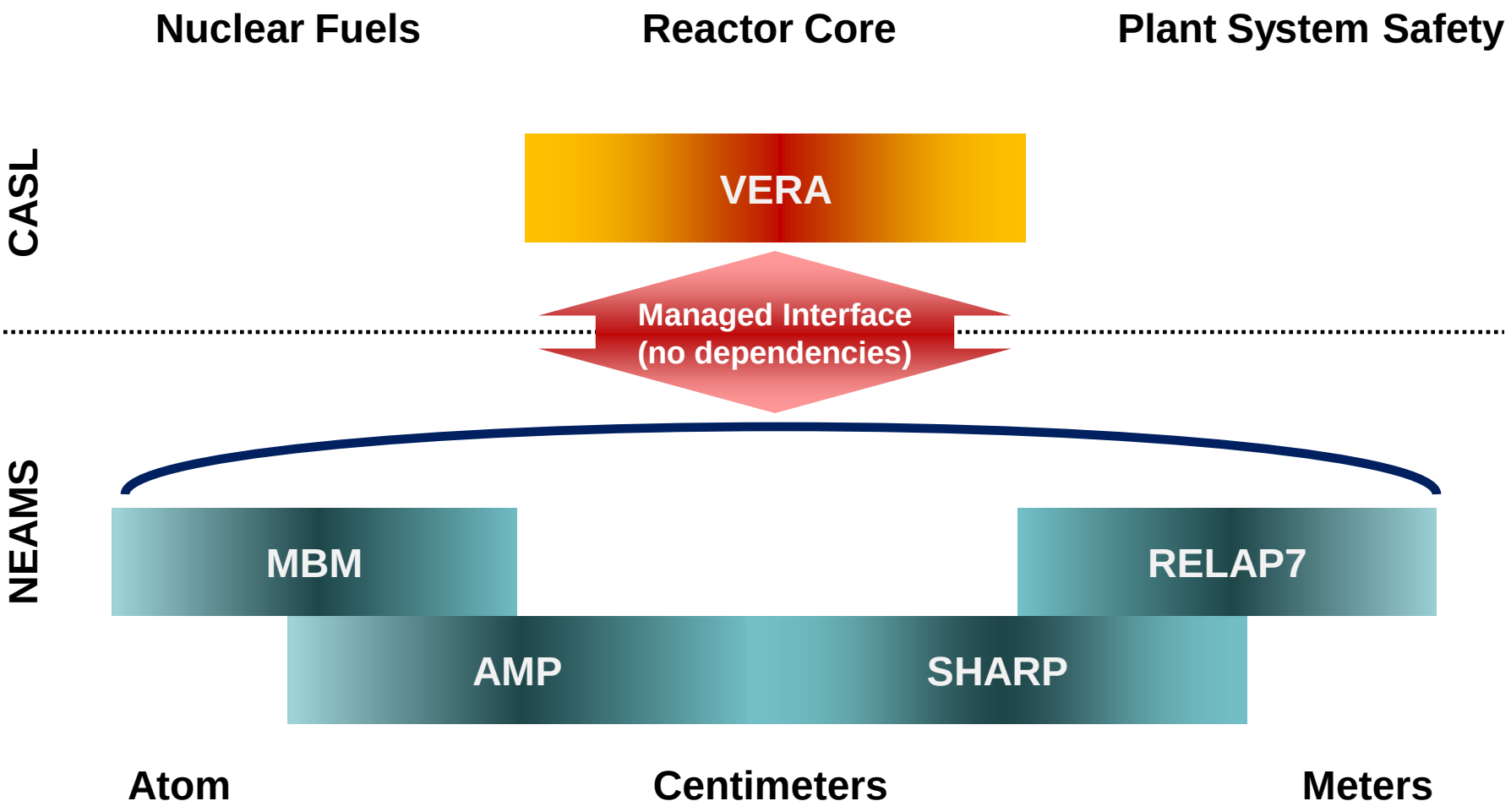
NE Advanced Modeling and Simulation Office Product Lines & Codes



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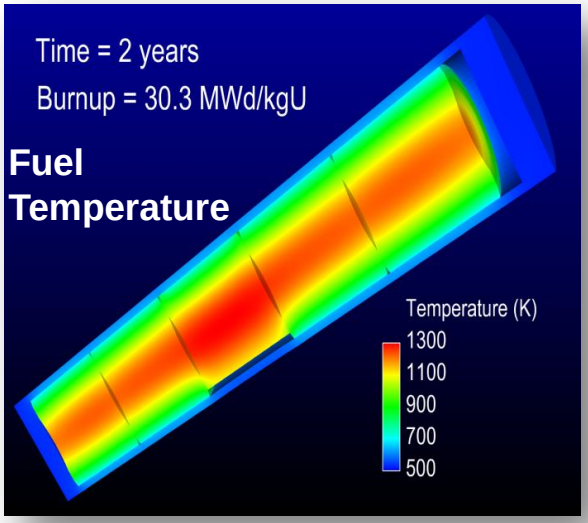
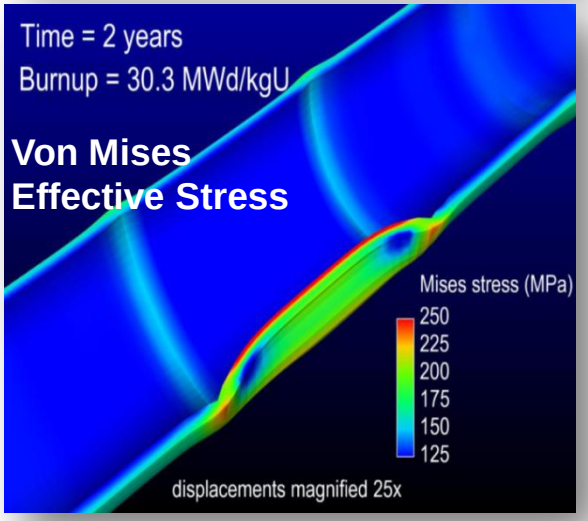
How Will the Codes be Used? Missing Pellet Surface

Cladding failure caused by missing pellet surface

- **Issue:**
  - Predict performance of an oxide fuel pellet with a missing surface
- **Role of Modeling and Simulation:**
  - Model physical behaviors
    - Thermal expansion
    - Fuel densification
    - Fuel swelling
    - Fuel and cladding creep
    - Gap conductance
    - Pellet-cladding interaction
    - More . . .
  - Simulate in a reactor environment
    - Coupled physics
    - 3D
    - Adequate simulation time and space





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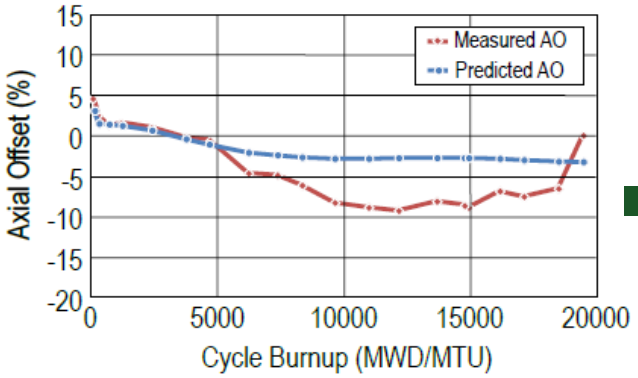
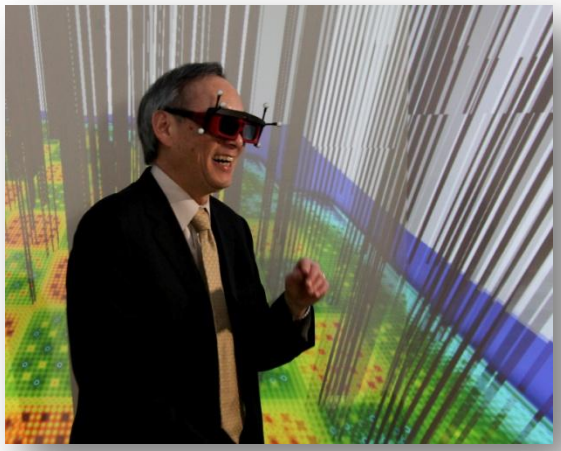
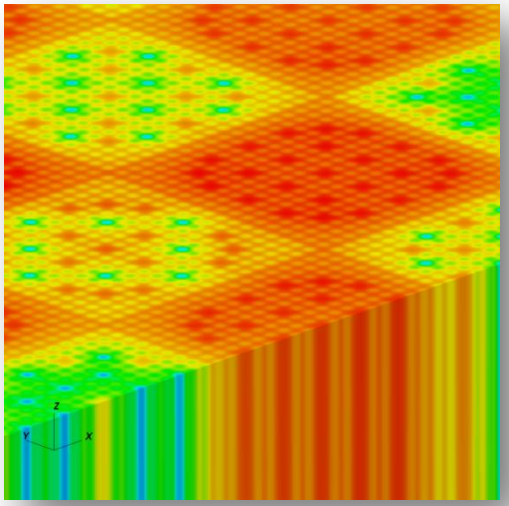
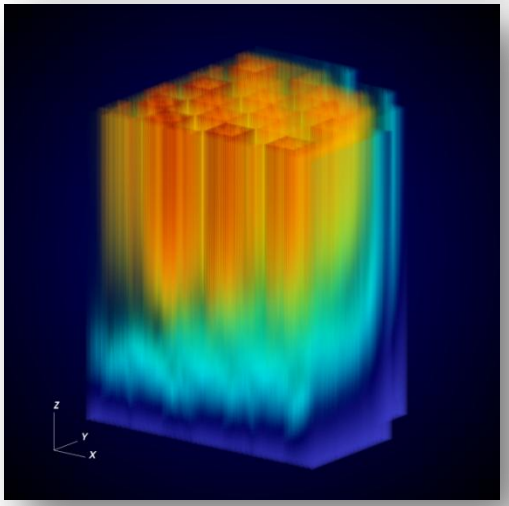
How Will the Codes be Used? CRUD Induced Power Shift





- **Issue:**
  - **Understand where CRUD forms in a reactor and its impact on the power shape**
- **Role of Modeling and Simulation**
  - Model Physical Behaviors
    - Pin resolved power
    - CRUD Deposition
    - Thermal Hydraulics
    - Neutronics
    - Assembly Structural Mechanics
  - Simulate in reactor environment
    - 3D
    - >50,000 pins
    - Assembly materials
    - Control rods
    - Adequate simulation time and space





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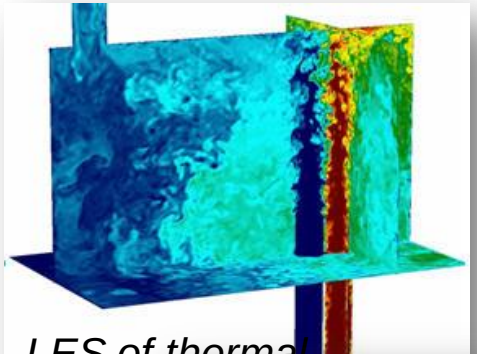
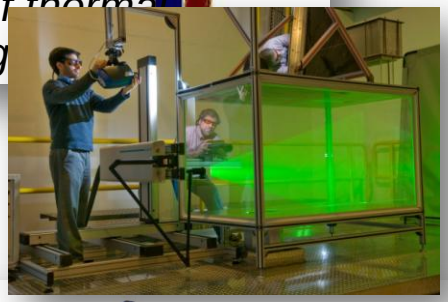
Modeling and Simulation Must Go Beyond Generating Pretty Pictures



LES of thermal mixing



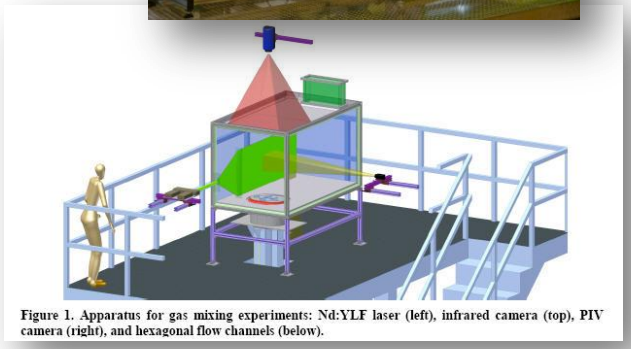
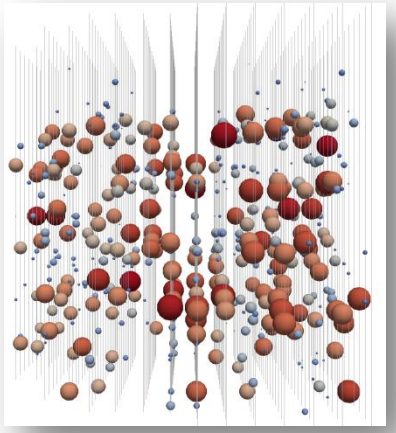


Figure 1. Apparatus for gas mixing experiments: Nd:YLF laser (left), infrared camera (top), PIV camera (right), and hexagonal flow channels (below).

- **Verification**
  - Proving that the models and simulation operate as they were designed
- **Validation**
  - Proving that the models and simulation represent reality
- **Uncertainty Quantification**
  - Understanding how far off the simulation results are from reality
- **Access to applicable experimental data is critical**

Vertical lines are individual flow channels



Flow direction

View inside the reactor core

Spheres denote locations where boiling occurs

- Size correlates to uncertainty
- Color correlates to mean boiling rate *(red is higher)*

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We Depend on Experiments!

- **Building Models**
  - We need single effect experimental observations to create models that represent physical phenomena
- **Validating Simulations**
  - We need integrated effect experiments to ensure that our simulations are correctly representing physical behaviors
- **Uncertainty Quantification**
  - We need to understand the sources of uncertainties and ways to reduce them as much as possible

- **But . . . We May Need New Approaches to Experiments**
  - Single effects that eliminate or screen out other phenomena
  - Experiments that make observations over time (particularly start-up)
  - Boundary conditions
  - Experimental uncertainties
  - Diagnostic behaviors
  - Observation interpretations processes
  - More . . .

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Panel Speakers